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# The co-ordination of building colours

*Experience in the use of BS 2660 'Colours for building and decorative paints' as a master range for co-ordinating the colours of building materials, including those with patterned or textured surfaces, showed that its colours were too few and that its framework failed to ensure consistent relationships. A new range based on the attributes hue, greyness and weight, instead of the hue, value and chroma of the Munsell system, is published in DD17:1972 'Basic range for the co-ordination of colours for building purposes'.*

*The new basic range is intended as a source from which specific ranges will be drawn for paints, ceramics, wall and floor coverings, etc. During its two-year life as a draft for development, the experience of users is being collected and, with any necessary amendments, it will then be published as a British Standard.*

The new colour range published by the British Standards Institution as a draft for development DD17:1972 'Basic range for the co-ordination of colours for building purposes'* is the outcome of proposals drawn up by the Building Research Station in consultation with government departments, the Royal Institute of British Architects and the Design Council. It consists of 182 colours organised on a framework based on new studies of colour attributes and colour harmony.

The purpose of the new range, the first of its kind, is to provide industry and designers with an instrument for bringing the colours of the various products and finishes used for building into a systematic relationship. It is seen as the source of a series of building colour standards, each for a specific type of product—paints, ceramics, floorings, etc—and drawing suitable colours from within the framework of the basic range.

The first of these derived standards, BS 4800:1972 'Paint colours for building purposes', became operative on 1 January 1973 when BS 2660 was withdrawn. This standard demonstrates the process of co-ordination intended to be followed during the two-year 'draft for development' phase of the basic range after which it is to be published with any necessary amendments as a British Standard. In effect, this two-year period is a comment stage during which the basic range is under test as a source for satellite ranges and standards. For example, it was found when drafting BS 4800 that technical limitations of paints in the orange region called for a weaker colour than the preferred oranges in the basic range. An additional colour was selected to fit into a vacancy in the basic range framework and is included in the BS 4800 card of eighty-eight colours; it will eventually be fed into the British Standard version of the basic range.

* British Standards Institution, London (£2·20).

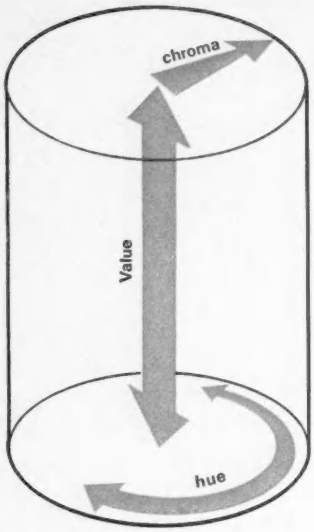



Fig 1 Diagram of Munsell solid

## Background developments

The first step towards defining a relationship between the colours of different building materials was taken in the early 1950s with the adoption of the Munsell system. This classifies colours in terms of three visual attributes—hue, value (lightness) and chroma (saturation or colourfulness)—and provides a scale of equal sensation steps for each attribute. The hue scale has 100 steps divided into ten bands, red, yellow-red, yellow, green-yellow, etc in spectral sequence; the value scale has ten steps from darkest (ideal black) to lightest (ideal white); the chroma scale extends from neutral grey (zero chroma) to maximum saturation, and may be divided into four bands, designated grey, weak, medium and strong. These three scales are represented geometrically by a cylindrical solid (Fig 1) in which value is scaled along the axis, chroma along the radii and hue around the circumference. Complete Munsell references are given in the order hue—value—chroma, for example 7.5R 6/2.

In addition to its role of classifying colours according to their estimated positions on these three scales, the Munsell system was seen as a means of extracting from the total gamut of colours a compact but representative range with common properties of hue, value and chroma. This was done in the design of the first colour standard specifically for building purposes, BS 2660:1955, which established a range of about 100 colours for building paints selected to fit into the Munsell framework.

In the absence of equivalent standards for other media than paint, a proposal was put forward jointly by BRS and RIBA in 1959 for building colour ranges generally to be co-ordinated with BS 2660. Two kinds of relationship with the standard were envisaged: direct matches, relevant to ranges for smooth plain-coloured versions of vitreous enamel, glazed tiles, flooring materials, etc; and an indirect relationship relevant to surface finishes with small-scale patterned or figured colouring or pronounced texture or both, such as marbled vinyl and linoleum flooring, figured plastics laminates, carpet, etc. Pilot examples of the second relationship had shown that co-ordination with BS 2660 depended on relating the composite or dominant colour appearance to a particular hue band, value level and chroma band of the Munsell framework rather than to individual colours in the standard.

Experience of co-ordination in these terms showed that, though the principle was valid, the colours of BS 2660 were too few, causing derived ranges to become repetitious, and that its framework failed to ensure consistent relationships.

A new and specially designed instrument was required which would be free from the constraints imposed by a particular medium and colouring process, and which would have a more definitive framework. As a result of special study, a new framework has been devised. Although still based on the Munsell system, it introduces some important modifications including two newly identified colour attributes: *greyness* and *weight.*

## The new framework for co-ordination

*Hue* is the attribute of colours discernible as a particular red, yellow-red, yellow, etc, regardless of other attributes. The Munsell hue bands used for BS 2660 allowed too much variation. The yellows, for example, switched about from the reddish end of the band to the greenish end and the same inconsistency occurred in other bands—

except purple which was represented by only one colour. Consequently hue relationships within most bands and between one band and another were inconsistent and too accidental as a basis for co-ordination.

The new framework abandons hue bands and adopts instead certain hue positions on the Munsell scale to allow sets of colours to be developed which in respect of hue can be consistent internally and relate consistently to each other. Every available hue on the Munsell scale was carefully considered and on the basis of the following three principles twelve were selected:

1 The hues should represent all major regions.

2 The identity of each hue should appear consistent at all levels of lightness and saturation.

3 The hues included should permit as many harmonious combinations as possible.

The final positioning of the twelve hues adopted is shown in Fig 2. Although at first sight their spacing appears somewhat scattered, the positions are justified in terms of the above principles. All major regions are represented, including the purplish which, because of paint pigment limitations, were sparsely represented in BS 2660. Two yellow-reds are included because one (10 YR) gives light browns without pinkness and browns in harmony with yellowish woods, stones and bricks; the other (7.5 YR), browns in harmony with reddish woods, etc. Two purple-blues are included; one (5 PB) for 'warm' blues as distinct from 'cool' (7.5 B), the other (10 PB) for violet, a valuable but neglected hue. Each of the twelve chosen hues pairs harmoniously with at least seven others on the basis of Moon and Spencer's[1] division into sectors of harmony and disharmony according to the distance between hues on the Munsell hue scale.

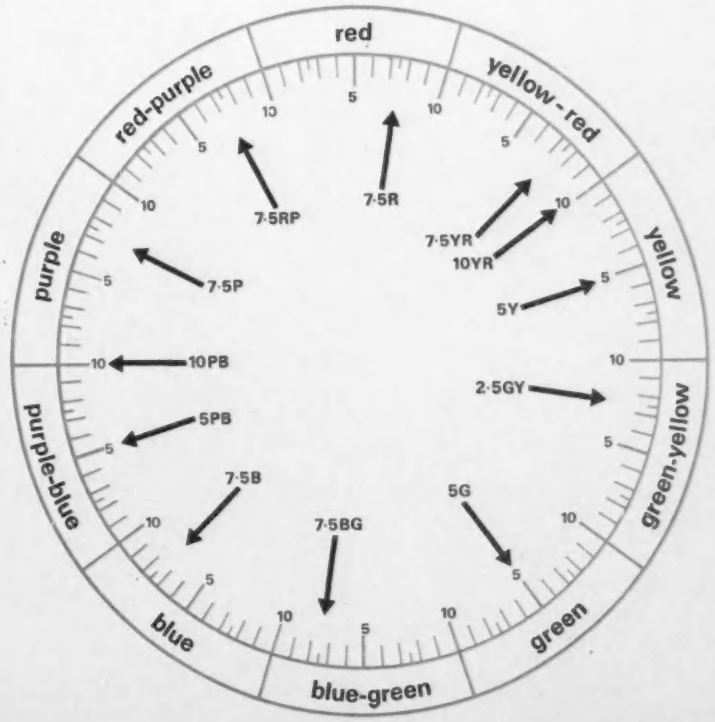


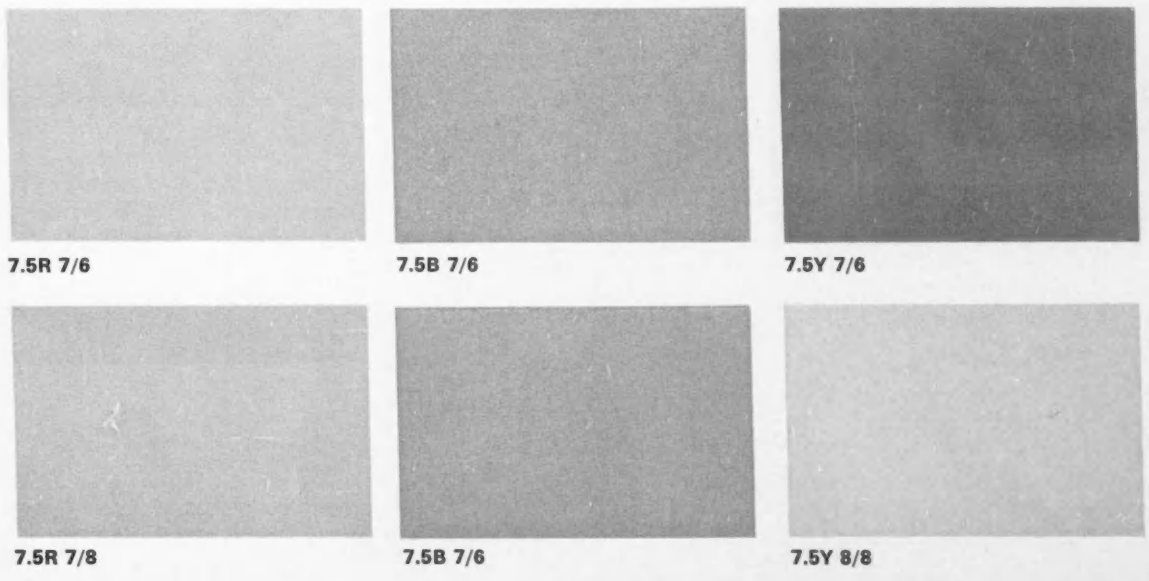

**Fig 2** Positions of the twelve specific hues of the new basic range on the Munsell hue scale

### Two new colour attributes

As just stated, the purpose of adopting specific hues instead of hue bands was to allow sets of colours to be developed in which hue would be consistent. If the other attributes in these sets were also consistent, there would be a considerable gain in flexibility since each colour in a given hue set would have its counterpart or equivalent colour in other hue sets. The failure of BS 2660 to provide this flexibility can be illustrated by one example. Colour 9-098 in the standard (very dark bluish-grey) has been much used for exterior cladding panels, but the reason could be that in seeking for a very dark subdued colour for such surfaces designers had no other choice. The other very dark colours (red, brown, yellow and green) were more saturated or colourful, though not equally so, and could certainly not be regarded as equivalents of the bluish-grey.

It was at first assumed that equivalent colours would come automatically from keeping Munsell value and chroma constant and varying only hue, but the results were not consistent. Significant differences often occurred, as appears in the top row of colours of Fig 3, and a reliable specification of equivalents depended on finding out what these differences were. Experiments eventually identified one of them as *greyness*, that is a difference in the apparent amount of greyness in one colour compared with another. It was found that this could be controlled by altering the chroma, and systematic data were obtained in the form of contours in the Munsell system connecting colours with the same estimated grey content, leading to a scale of four steps of diminishing greyness from maximum to minimum, beyond which colours were free of greyness or 'clear'. The contours at a middle value are illustrated in Fig 4 and show considerable deviation from the concentric circles of equal chroma, particularly in the

**Fig 3** Colours in upper row have equal Munsell value and chroma (7/6) but look different in character. The problem was to identify the nature and extent of adjustments needed to bring them into line, as in the lower row (blue kept the same)



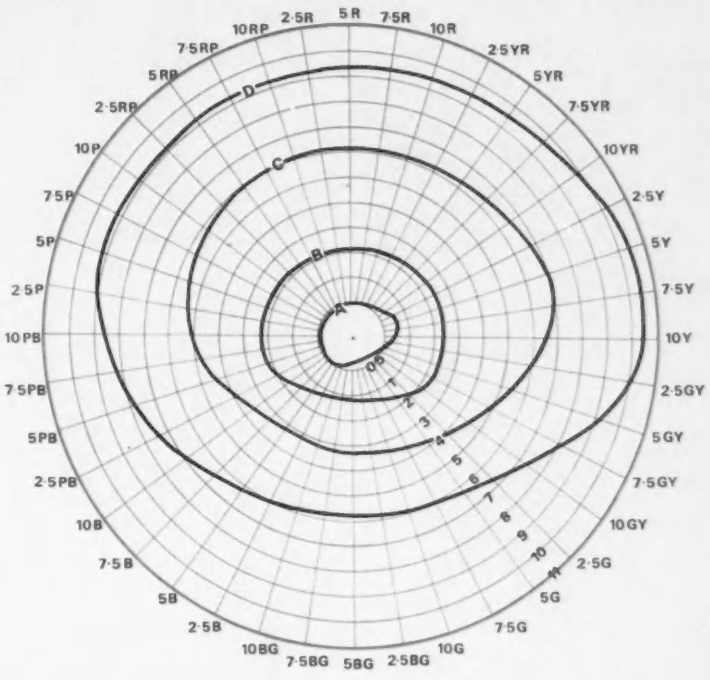



**Fig 4** Horizontal section through Munsell solid at value 6 showing contours of greyness categories A to D. Outside the D contour (minimum greyness) colours are clear (category E)

blue, blue-green and green hues where colours reach zero greyness much sooner than in other hues. At value levels above 6 and below 3, the extent of greyness diminishes in all hues and at the top and bottom of the value scale it disappears and white and black are clear. The five categories of greyness defined by the contours lettered A (maximum greyness) to E (zero-greyness or clear) have been adopted for the new framework.

Although the use of constant greyness instead of constant chroma brought reliable specification of equivalent colours in the different hues very much closer, inconsistencies still occurred among colours in the minimum and zero-greyness categories (D and E), due to a further difference for which the subjective term *weight* has been adopted. For example, when series of colours were examined representing all twelve hues at fixed minimum greyness (D) and fixed value (5), it was found that while this formula produced equivalent colours for most hues, the yellowish (yellow-red, yellow and green-yellow) did not conform and looked too 'heavy' in comparison with the others. The difference could be eliminated by slightly raising the value of the yellowish colours, resulting in a series through all twelve hues which now looked acceptably uniform in weight though it was no longer uniform in value. This is illustrated by the bottom row of colours in Fig 3. In category E, adjustments to the values of the yellowish colours in a series had to be somewhat greater and, in addition, a slight downward instead of upward adjustment of value was desirable in violet. In greyness categories A and B, and substantially in C, no special adjustments to value were needed.

The requirements for the new framework were now met. The twelve specific hues brought hue relationships under more precise and sophisticated control, while the two new attributes of greyness and weight in combination solved the problem of specifying equivalent colours in the different hues and overcame the inadequacies of the Munsell system in this respect.

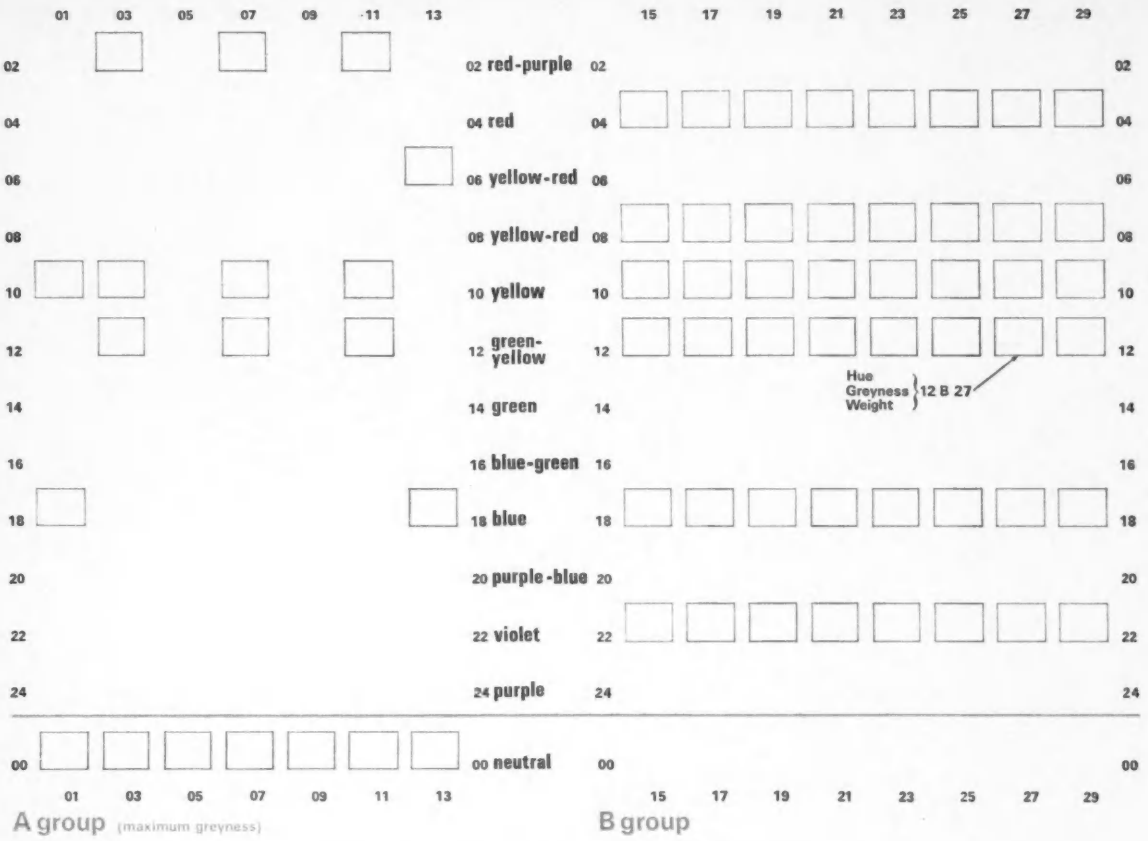
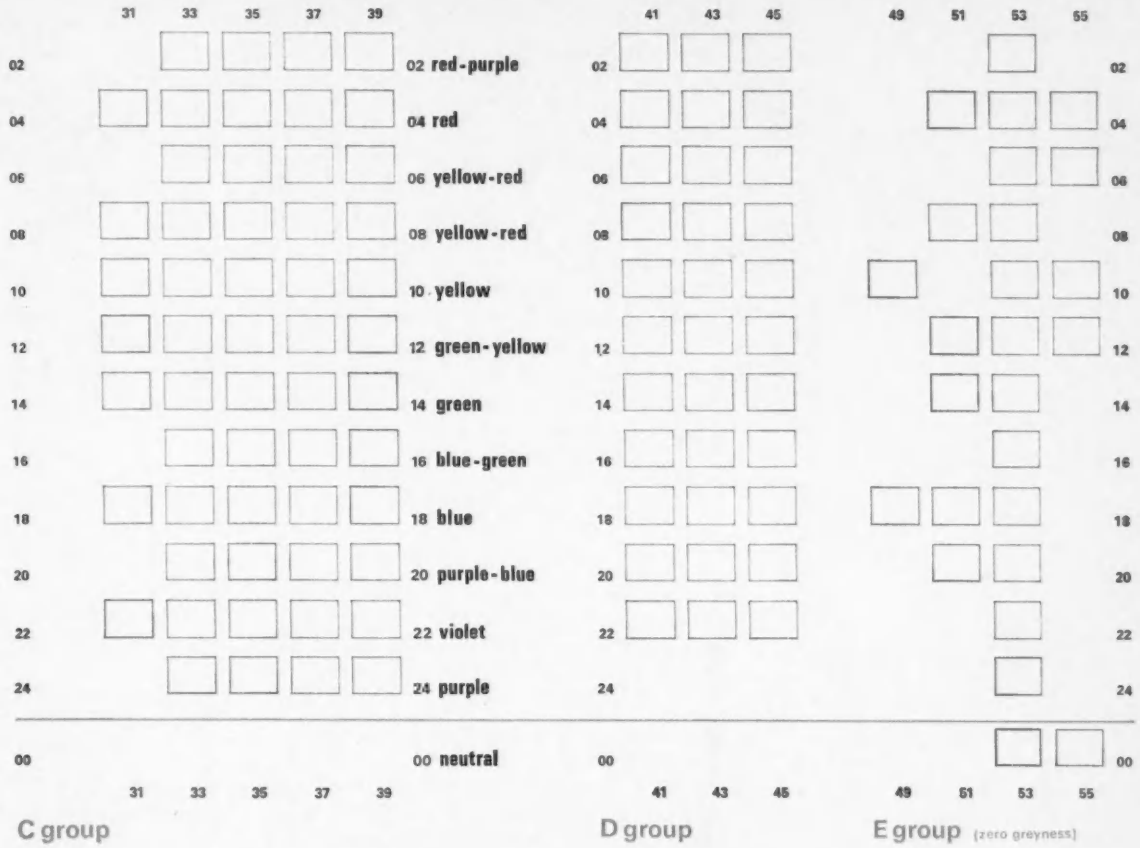



**Fig 5** Systematic layout of the basic range in hue rows plus a row for neutral colours, greyness groups (A to E) and columns of equal weight graded from lightest weight on the left to heaviest weight on the right

### Contents of the basic range

The layout of the basic range within the new framework is shown in Fig 5, but for the colour representation reference must be made to DD 17. The twelve hues are represented by horizontal rows in sequence from red-purple at the top to purple at the bottom, with a further row below for neutral colours. The range is divided into five groups, A to E, representing the five steps of diminishing greyness from maximum to zero-greyness. A and B groups comprise the subdued colours; C, D and E groups the more pronounced colours ascending to fullest power in E. Within each group, colours are in vertical columns of equal weight, up to eight in number, graded from lightest weight on the left of each group to heaviest on the right. If this framework were fully represented by colours, the total range would approach 500, but in practical terms considerable economies are possible and the number contained in the basic range as published, 182, is considered to be of the right order for co-ordination purposes. The colours are identified in the sequence hue (the horizontal rows), greyness group (A to E) and weight (the vertical columns), for example 12 B 27 as shown in Fig 5.

In A group, the colours included are of three kinds: a sequence of neutral greys (row 00), essential for many different practical purposes; a pair of near-whites and near-blacks (columns 01 and 13) to supplement the clear white and black in E group and representing the preferred 'warm' and 'cool' variants in these subtle but important regions; and finally three small sets of tinted greys (columns 03, 07 and 11) which are valuable in themselves as very subdued colours




and also provide alternatives to the neutral colours where, through contrast with surrounding colours, the latter would appear too 'cool' and bluish. They are needed in only three hues (red-purple, yellow and green-yellow) because their very high grey content allows them to combine satisfactorily with colours elsewhere in the range of all but the two hues blue and violet, with which neutral greys are satisfactory.

B group contains subdued or background colours suitable for use on whole surfaces such as walls, panels and floors. 'Warm' hues are more fully represented than 'cool' because they are generally preferred for main interior and exterior surfaces and a full quota should be available; also, loss of visual discrimination between hues due to the high grey content of colours in this group is less noticeable among the 'warm' than the 'cool' hues and permits a reduction of the latter to two (blue, 7.5 B, and violet, 10 PB). Some small adjustments to the hues were found necessary. In the red row the hue is shifted from the chosen 7.5 R to the yellower 10 R to offset the purplish tendency which occurs at low saturation and high greyness. The two yellow-red rows in C, D and E groups are merged in this group into one of intermediate hue (8.75 YR) because practical colour tolerances at this high greyness would otherwise lead to overlapping. A full span of equal weight columns from lightweight to heavyweight is given for each of the hues included to provide for the many different applications these subdued colours have in practice, including the use of two or three of the same hue for the specification of marbling or figuring designs in floor and wall coverings. The right-hand column in this group serves as the main source of very dark or heavy colours in the range and, unlike the very dark colours in BS 2660 discussed earlier, its contents are tuned to be strictly equivalent to each other.

In C group, where colours are beginning to emerge from greyness and discrimination between hues is noticeably sharpened, the full quota of twelve comes into use, but economy can still be made in the number of equal weight columns. The first two columns on the left link with the first two in B group to form the main source of lightweight colours. Very dark or heavy colours are omitted in favour of those given in Group B, while of the five possible middleweight columns, the three included (based on Munsell values 7, 5 and 3) give sufficient coverage.

D group colours, with minimum greyness, are powerful enough to rank as strong accent colours and would normally be used in limited areas. They are represented by three middleweight columns extending to all hues except purple where they appear unacceptably harsh. Light and heavyweight columns are omitted in favour of the more restrained versions in C and B groups.

Finally, E group contains the clear colours in the range. The main column includes all twelve hues of the framework, supplemented by certain extra hues in the right-hand adjacent column to fill gaps which are evident because in this region hue discrimination is nearing its peak. Clear white and black are placed at the foot of these columns, a reminder that despite their lack of hue they are positive and powerful in character. Immediately to the left of the main column is a briefer one to provide a bridge between full power and the modified power of D group colours. Apart from the usefulness of these bridge colours as colours, they are also reserves for media in which for technical reasons full power is difficult or impossible to attain in some hues. It is this column, for example, which will accommodate the extra orange colour chosen for BS 4800 for paint colours. The left-hand column in E group is the potential source of clear lightweight colours, though only two hues are represented, yellow and blue, on the grounds that other hues are better and sufficiently served in B and C groups.

Since the Munsell system has been the means of defining the framework of the basic range and therefore still has an indispensable role in colour co-ordination approximate Munsell references for all basic range colours are given in an appendix to DD17. Most of the irregularities of hue, value and chroma within the various rows and columns in the basic range reflect deviations involved in obeying the new framework and new attributes, but occasionally they result from compromises in order to retain as many BS 2660 colours as possible and thus ease the transition from the old basis of colour co-ordination to the new. Altogether about half the colours of BS 2660 are either matched or have 'near-equivalents' in the basic range.

**Reference**

1 *Geometrical formulation of classical colour harmony* P Moon and D E Spencer, J Opt Soc Am, Vol 34(1) : Jan 1944.

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